Title: Method and Apparatus for Rendering Shadows Inventors: Thomas David Lokovic et al.

Sheets of drawings 1 of 25

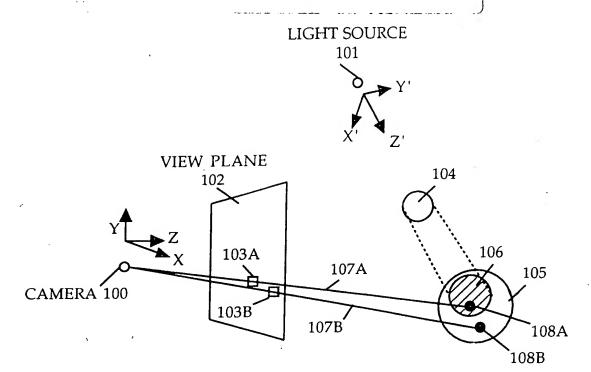


FIGURE 1 **PRIOR ART**

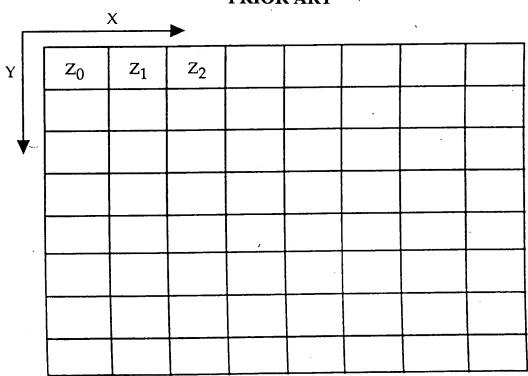
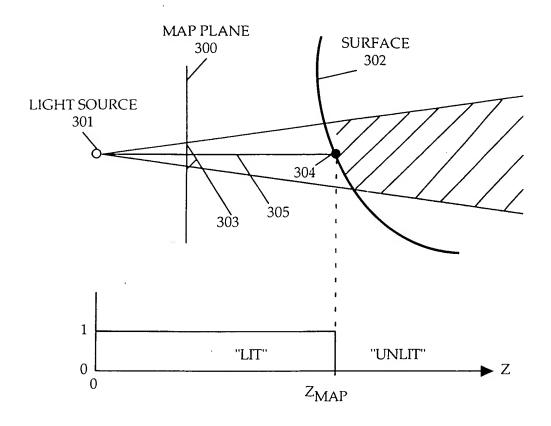


FIGURE 2 PRIOR ART

Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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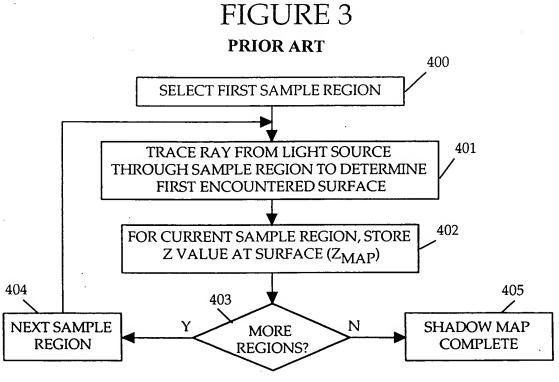


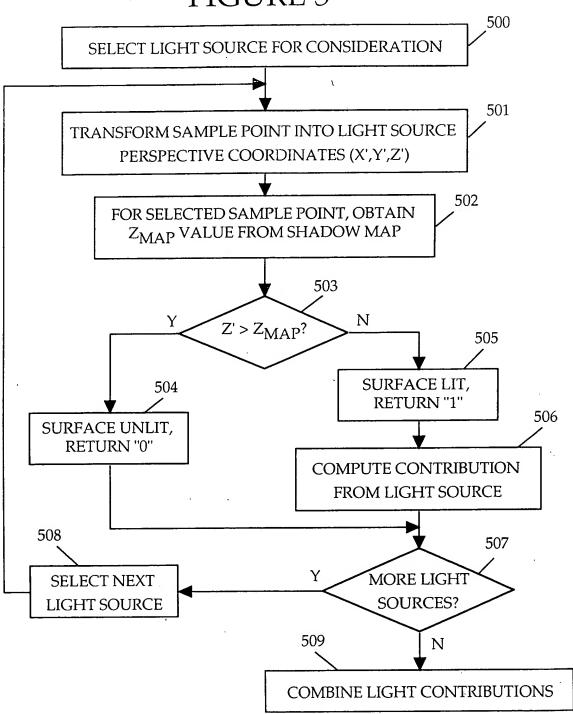
FIGURE 4
PRIOR ART

Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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FIGURE 5



PRIOR ART

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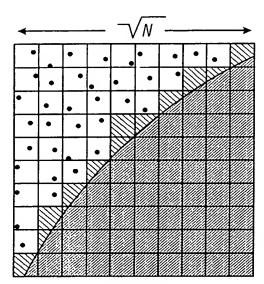


FIGURE 6A PRIOR ART

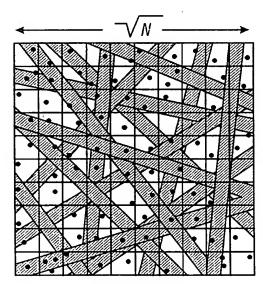


FIGURE 6B PRIOR ART

Daniel Mao, Reg. No. 51,995 Telephone: 650-326-2400 Title: Method and Apparatus for Rendering Shadows Inventors: Thomas David Lokovic et al. Sheets of drawings 5 of 25 900 SELECT CURRENT MAP LOCATION 901 CHOOSE SAMPLE RAYS WITHIN FILTER REGION 902 DETERMINE TRANSMITTANCE FUNCTION τ_i FOR EACH SAMPLE RAY 903 DETERMINE VISIBILITY FUNCTION FOR MAP LOCATION FROM ASSOCIATED TRANSMITTANCE FUNCTIONS 904 COMPRESS VISIBILITY FUNCTION 905 STORE COMPRESSED VISIBILITY **FUNCTION IN MAP LOCATION** FIGURE 9

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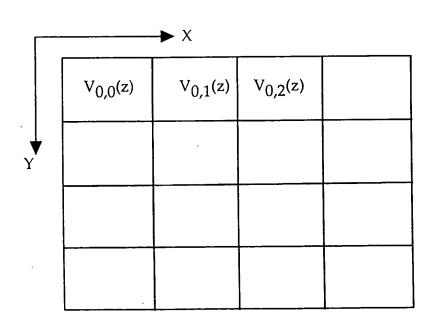


FIGURE 7

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Inventors: Thomas David Lokovic et al.
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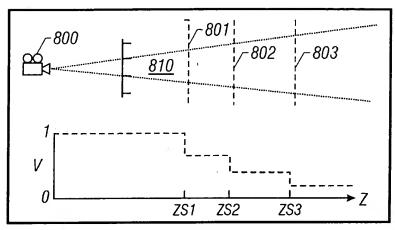


FIGURE 8A

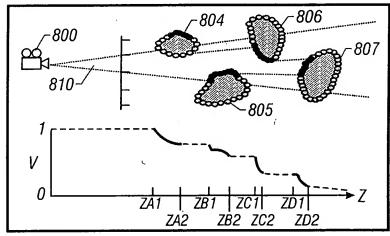


FIGURE 8B

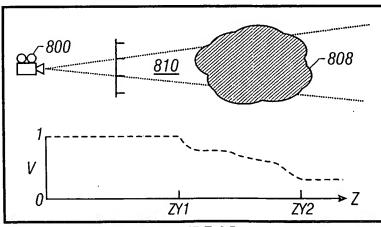
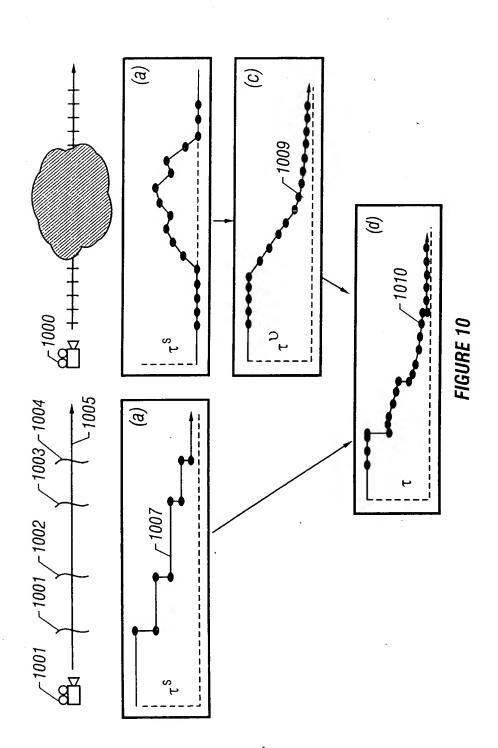


FIGURE 8C

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Inventors: Thomas David Lokovic et al.
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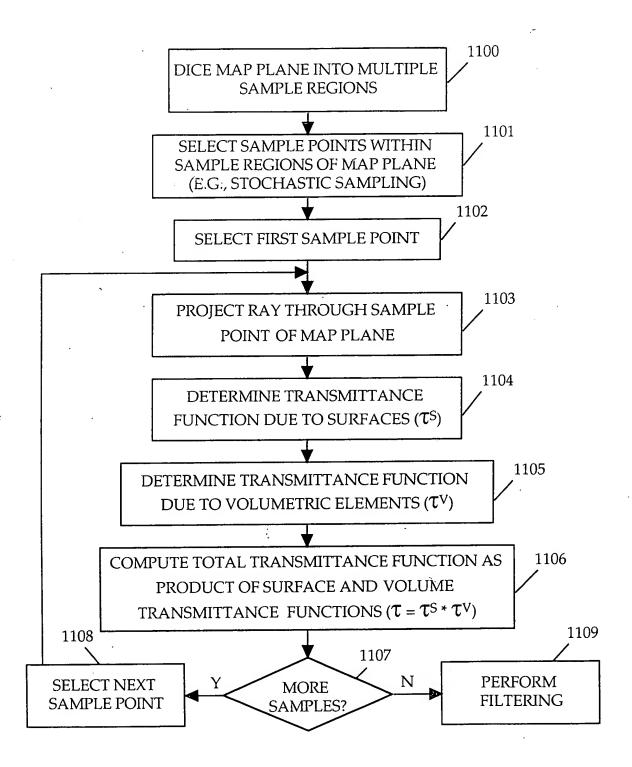


FIGURE 11A

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Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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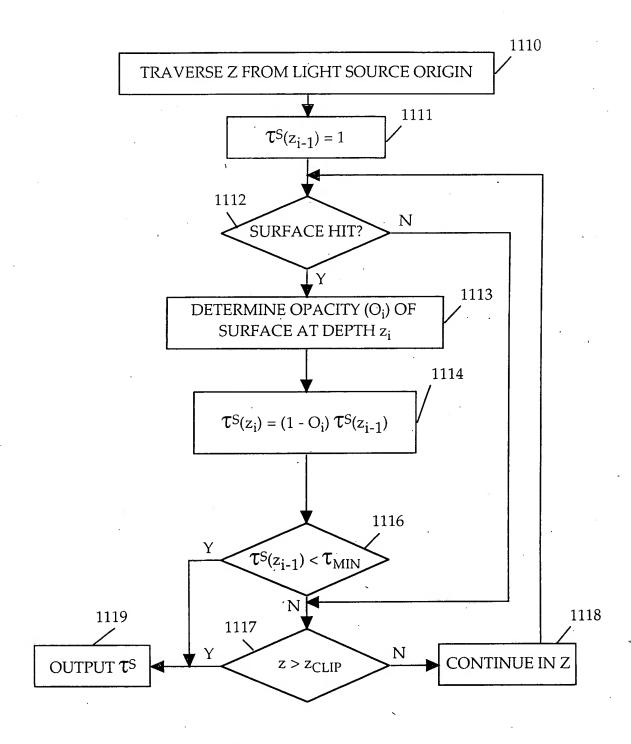


FIGURE 11B

Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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TRAVERSE Z, SAMPLING ATMOSPHERIC DENSITY AT INTERVALS TO GENERATE AN EXTINCTION COEFFICIENT \mathbf{K}_i AT EACH DEPTH \mathbf{z}_i

LINEARLY INTERPOLATE EXTINCTION COEFFICIENTS TO OBTAIN EXTINCTION FUNCTION K(z)

INTEGRATE AND EXPONENTIATE EXTINCTION FUNCTION TO OBTAIN VOLUME TRANSMITTANCE $\boldsymbol{\tau}^{\text{V}}$

FIGURE 11C

EVALUATE INCREMENTAL TRANSMITTANCE T_i AT EACH VERTEX OF EXTINCTION FUNCTION $T_i = \exp(-(z_{i+1} - z_i)(\mathbf{K}_{i+1} + \mathbf{K}_i)/2)$

MULTIPLY INCREMENTAL TRANSMITTANCE
VALUES TO OBTAIN VOLUME TRANSMITTANCE
AT EACH VERTEX DEPTH

$$\tau^{V}(z_i) = \prod_{j=0 \text{ to } i} (T_j)$$

LINEARLY INTERPOLATE VOLUME TRANSMITTANCE FUNCTION FROM VERTEX VALUES

FIGURE 11D

1121

1120

1122

1123

1124

124

1125

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Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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С	В	В	С
В	Α	Α	В
В	A	Α	В
С	В	В	С

FIGURE 12

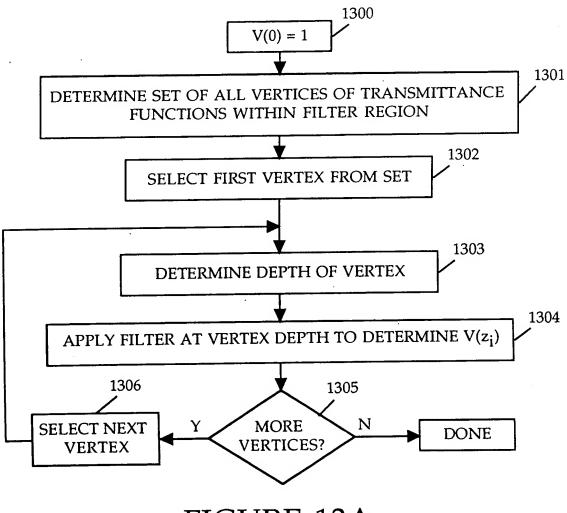


FIGURE 13A

021751-001710US Daniel Mao, Reg. No. 51,995 Telephone: 650-326-2400 Title: Method and Apparatus for Rendering Shadows Inventors: Thomas David Lokovic et al. Sheets of drawings 12 of 25 1307 V(0) = 11308 CALCULATE INITIAL VISIBILITY SLOPE M_V(0) AS WEIGHTED SUM OF TRANSMITTANCE SLOPES 1309 DETERMINE SET OF ALL VERTICES OF TRANSMITTANCE FUNCTIONS WITHIN FILTER REGION 1310 DETERMINE DEPTH z_i OF NEXT VERTEX 1311 DETERMINE VISIBILITY FUNCTION VALUE AT DEPTH zi USING CURRENT VISIBILITY SLOPE VALUE 1312 FOR VERTEX'S TRANSMITTANCE FUNCTION, DETERMINE PRIOR SLOPE VALUE AND NEW SLOPE VALUE 1313 VERTICAL STEP? 1314 CALCULATE NEW VISIBILITY SLOPE VALUE BY: SUBTRACTING PRIOR WEIGHTED TRANSMITTANCE SLOPE VALUE; AND ADDING NEW WEIGHTED TRANSMITTANCE SLOPE VALUE 1315 Υ **MORE DONE** ERTICES?

FIGURE 13B

1316

NEXT

VERTEX

Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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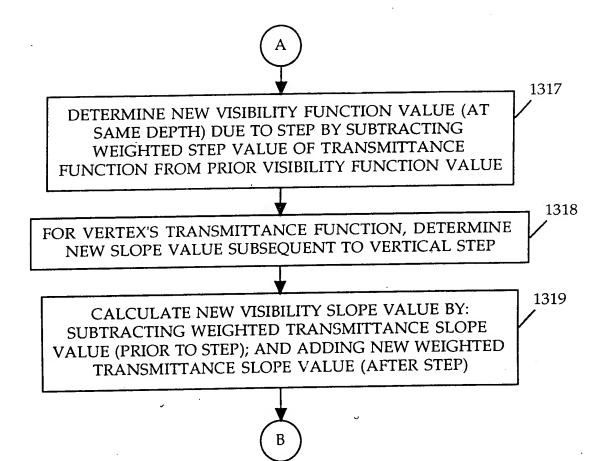


FIGURE 13C

021751-001710US Daniel Mao, Reg. No. 51,995 Telephone: 650-326-2400 Title: Method and Apparatus for Rendering Shadows Inventors: Thomas David Lokovic et al. Sheets of drawings 14 of 25 1400 **ORIGIN OF CURRENT OUTPUT** SEGMENT IS (z'_i,V'_i) 1401 SET CURRENT SLOPE RANGE $[M_{LO}, M_{HI}]$ EQUAL TO $[-\infty, \infty]$ 1402 CONSIDER NEXT INPUT VERTEX (z_i, V_i) 1403 N $(V_j + \varepsilon - V_i')/(z_j - z_i') < M_{HI}$? 1405 $M'_{HI} = M_{HI}$ $M'_{HI} = (V_j + \varepsilon - V'_i)/(z_j - z'_i)$ 1406 N $(V_j - \varepsilon - V_i)/(z_j - z_i) > M_{LO}$? 1408 $M'_{LO} = (V_j - \epsilon - V'_i) / (z_j - z'_i)$ $M'_{LO} = M_{LO}$ 1409 $M'_{LO} < M'_{HI}$? 1411 , N RETURN TO DEPTH z_j OF PRIOR INPUT VERTEX 1412 DEFINE OUTPUT SEGMENT TO BE SEGMENT WITH SLOPE (M_{LO}+M_{HI})/2 ENDING AT DEPTH z_i 1413 **ENDPOINT OF SEGMENT BECOMES**

1404

1407

1410

 $M_{LO} = M'_{LO}$

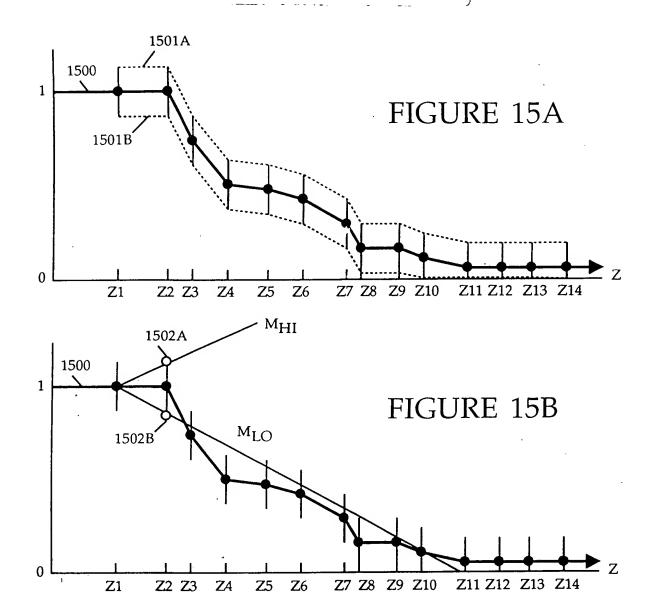
 $M_{HI} = M'_{HI}$

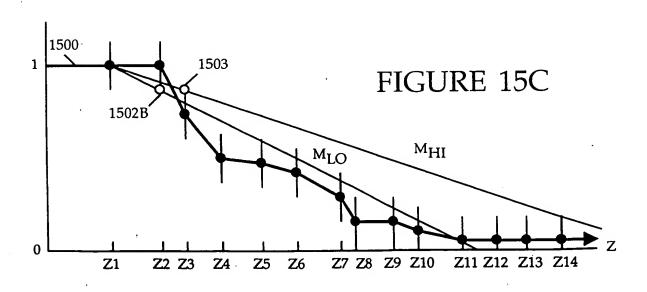
FIGURE 14

ORIGIN OF NEXT OUTPUT SEGMENT

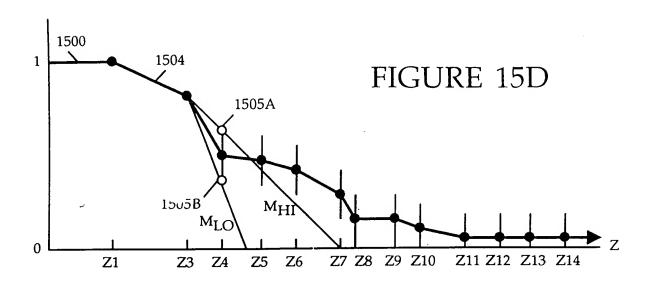
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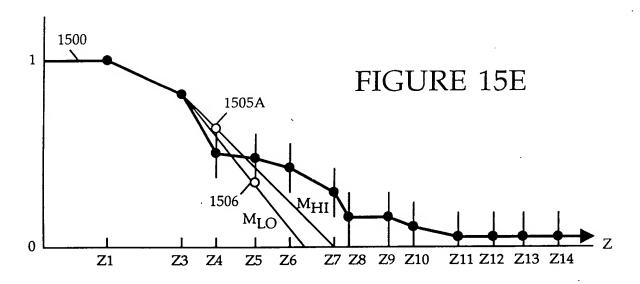


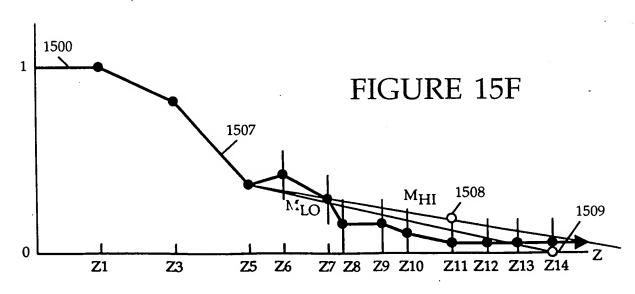




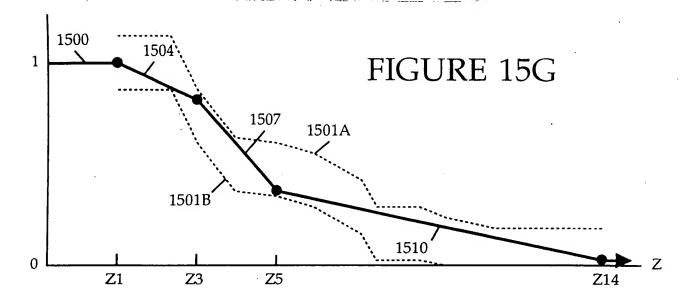
Title: Method and Apparatus for Rendering Shadows Inventors: Thomas David Lokovic et al. Sheets of drawings 16 of 25







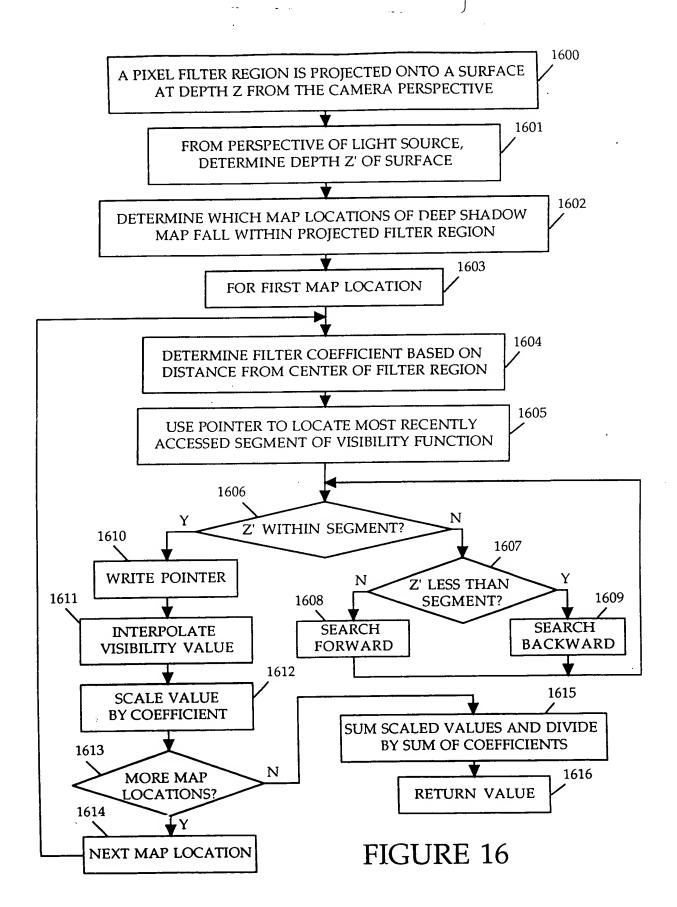
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Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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Sheets of drawings 19 of 25 1702 1701 1700 0 1703B 1703A 1704B 1704A POINTER: POINTER: LAST_SGMNT (*MVERTEX) LAST_SGMNT (*CVERTEX) 1705B 1705A FLAG: FLAG: COLOR (BOOLEAN) **COLOR (BOOLEAN)** 1706B 1706A ARRAY: ARRAY: VISIBILITY[] (MVERTEX) VISIBILITY[] (CVERTEX) 1707B 1707A **CVERTEX**: **MVERTEX:** DEPTH (FLOAT); DEPTH (FLOAT); VALUE_R (FLOAT); VALUE (FLOAT) 1707B VALUE_G (FLOAT); VALUE_B (FLOAT) **MVERTEX**: DEPTH (FLOAT); VALUE (FLOAT) 1707A 1707B **CVERTEX:** DEPTH (FLOAT); **MVERTEX**: VALUE_R (FLOAT); DEPTH (FLOAT); VALUE_G (FLOAT); VALUE (FLOAT) VALUE_B (FLOAT)

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Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

FIGURE 17

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Telephone: 650-326-2400
Title: Method and Apparatus 6

Title: Method and Apparatus for Rendering Shadows Inventors: Thomas David Lokovic et al.

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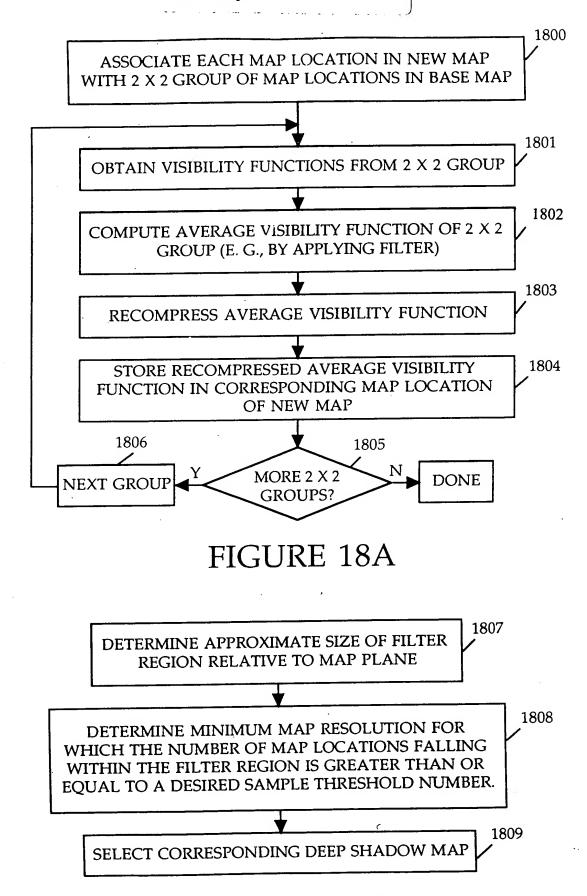


FIGURE 18B

021751-001710US Daniel Mao, Reg. No. 51,995 Telephone: 650-326-2400 Title: Method and Apparatus for Rendering Shadows Inventors: Thomas David Lokovic et al. Sheets of drawings 21 of 25 1901A 1900A 1901B . 1900B

FIGURE 19

Title: Method and Apparatus for Rendering Shadows

Inventors: Thomas David Lokovic et al.

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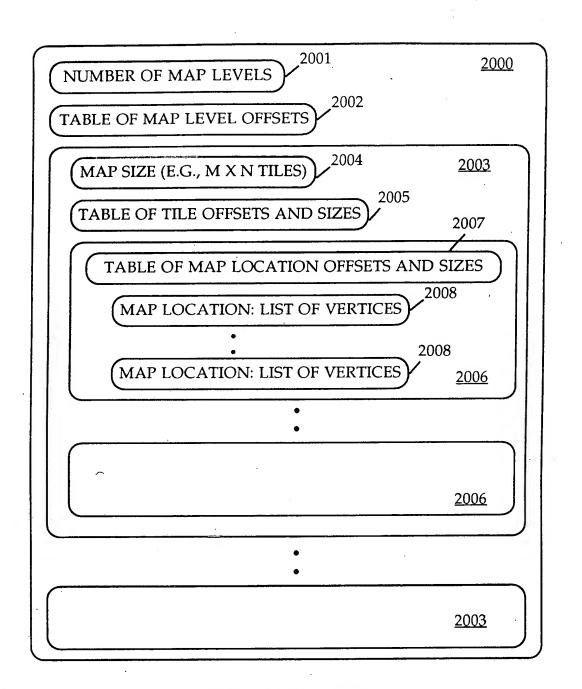
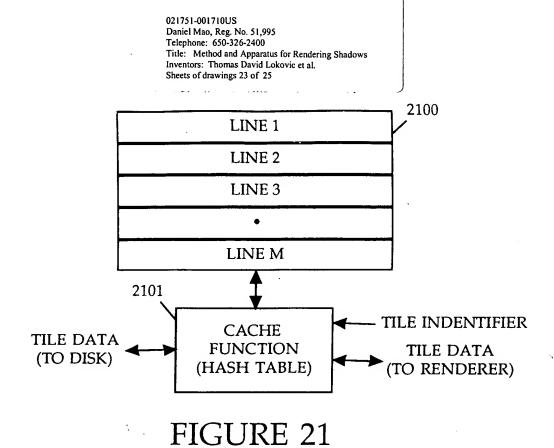


FIGURE 20



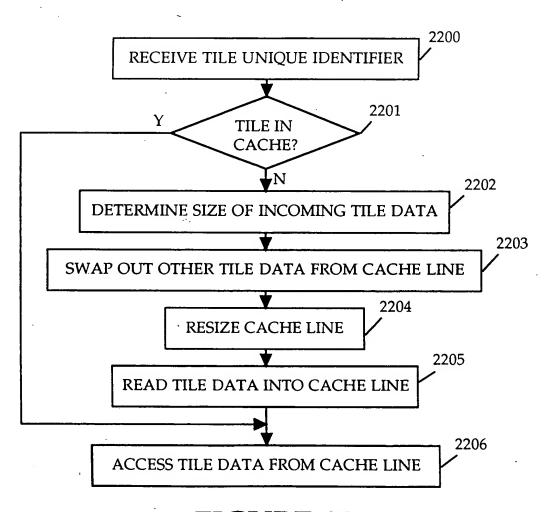


FIGURE 22

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Inventors: Thomas David Lokovic et al.
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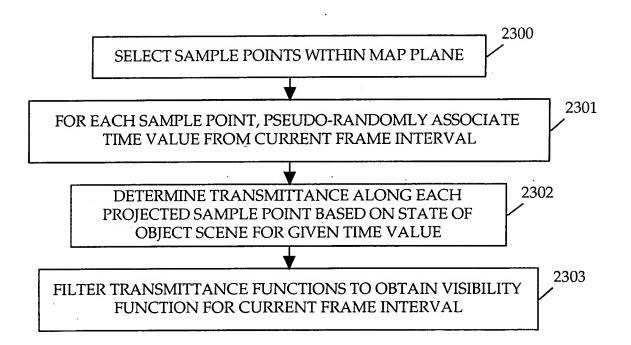


FIGURE 23

